

1                   **METHOD AND APPARATUS FOR ADHESIVELY BONDING**  
2                   **CORNER PROTECTORS ONTO PICTURE FRAMES AND THE LIKE**

3                   BACKGROUND OF THE INVENTION

4           A.     Field of the Invention

5           The present invention relates to methods and apparatus for protecting the  
6 corners of rectangularly-shaped frames such as picture frames, from impact damage during  
7 shipping. More particularly, the invention relates to a method and apparatus for adhesively  
8 bonding corner protectors onto the corners of a picture frame.

9           B.     Description of Background Art

10          Picture frames for holding and displaying paintings, photographs, diplomas, certificates and  
11 similar flat articles are manufactured in prodigious quantities worldwide. Although picture  
12 frames vary in shape and construction details, most frames have a rectangular plan view  
13 shape. Moreover, the structure of most picture frames consists essentially of four elongated,  
14 straight channel members or moldings, each having formed therein an inner longitudinally  
15 disposed channel that intersects channels of adjacent members at ninety degree angles. Four  
16 such channel members fastened together form a rectangular ring-shaped frame. The  
17 channels or recesses in the moldings face inwardly of the frame, and comprise spaces for  
18 receiving a rectangularly-shaped flat display piece such as a photograph or painting, and  
19 sometimes, a backing panel, mat and protective cover glass.

20          Picture frames of the type described above are made from a variety of materials  
21 including, wood, metal and plastic. Whatever material the frame is made of, the geometry of  
22 a rectangular picture frame dictates that it have four peripheral members or moldings of  
23 generally uniform thickness which are joined to each other at forty-five degree miter angles to  
24 form ninety-degree corners. Since the sides of each molding intersect at an acute angle, i.e.,  
25 45 degrees, the frame corners as well as the molding corners are sharp, and are therefore  
26 highly subject to breakage, denting or cosmetic damage during shipment. Accordingly, most  
27 picture frames, whether empty or occupied, are fitted with some sort of corner protectors  
28 during shipment. Such corner protectors are usually made of a relatively inexpensive

1 recyclable material such as cardboard or polystyrene foam. Typical corner protectors of this  
2 type are disclosed in U.S. Pat. Nos. 3,955,677, 4,598,825, and 5,447,233. Other patents,  
3 related to protecting corners of objects during shipping include U.S. Pat. No. 4,407,898. Also,  
4 U.S. Pat. No. 5,255,458 discloses a three-dimensional picture corner and U.S. Pat. No.  
5 4,787,553 discloses a corner fastening device.

6 In addition to the above-referenced patents related to corner protectors and the  
7 like, a variety of machines for bending sheet metal or cardboard of the type used for corner  
8 projectors have been disclosed in the following U.S. Pat. Nos: 4,132,102, 4,585,432,  
9 4,713,957, 4,857,038, 4,956,961, and 5,184,998.

10 None of the aforementioned references disclose a machine for automatically  
11 attaching corner protectors to picture frames. Accordingly, the task of attaching corner  
12 protectors to picture frames was formerly labor intensive and time consuming. In response to  
13 those limitations of the prior art, the present inventor disclosed an automatic Method and  
14 Apparatus For Attaching Corner Protectors to Picture Frames, in U.S. Patent No. 6,018,934.  
15 In that patent, the present inventor disclosed a method and apparatus for installing covers to  
16 protect picture frame corners from damage during shipment, utilizing thin cardboard preforms  
17 having symmetric, left and right-hand, right-triangular cover flaps joined at vertical sides thereof  
18 to opposite vertical sides of a vertically elongated, rectangular spine flap, the left-hand  
19 triangular cover flap having depending downwardly from its base a horizontally elongated  
20 rectangular side cover flap, and depending downwardly from the lower lateral edge of the side  
21 cover flap a trapezoidally-shaped securement flap. The preform is positioned below a picture  
22 frame corner, with intersecting side members of the frame vertically aligned with the sides of  
23 the left-hand right-triangular cover flap, which serves as a lower face cover flap. The  
24 apparatus includes folder mechanisms including flap folder arms which are retractable into  
25 recesses provided in a work table, and which are extendible and rotatable to thereby bend the  
26 side cover flap and securement flap into a vertical position adjacent a first side of the frame  
27 corner and perpendicularly inwardly to overlies the first frame member, bend the spine flap and  
28 right-hand triangular cover flap into a vertical position adjacent the second frame member, and

1 bend the right-hand triangular flap perpendicularly inwards from the spine flap to overlie the  
2 second and first frame members. An automatic staple gun then inserts a staple downwardly  
3 through the right-triangular cover flap into the securement flap and left-hand frame member,  
4 securing the corner protector in a folded disposition over the frame corner. The present  
5 invention was conceived of to provide a method and apparatus for adhesively bonding corner  
6 protectors on the corners of picture frames, the method and apparatus being suitable for use  
7 with picture frames made of metal or plastic, as well as wood.

#### 8 OBJECTS OF THE INVENTION

9 An object of the present invention is to provide a method for attaching protective  
10 covers to the corners of a picture frame, using an adhesive bonding process.

11 Another object of the invention is to provide an apparatus for automatically  
12 attaching protective covers to the corners of picture frames using adhesive bonds.

13 Another object of the invention is to provide a method and apparatus for  
14 automatically attaching protective covers to the corners of picture frames, in which a cover is  
15 bonded to the corner of a frame by an adhesive bond, not requiring penetration of the frame  
16 by a fastener.

17 Another object of the invention is to provide a method and apparatus for  
18 automatically attaching protective covers to corners of a picture frame in which adhesive is  
19 applied to a surface of a frame molding, a protective cover is positioned over the cover, and  
20 the cover pressed against the adhesive to bond the cover to the frame molding.

21 Another object of the invention is to provide an apparatus for depositing a  
22 quantity of adhesive on a surface of a picture frame molding, folding a flat sheet of flexible  
23 material over the corner of a picture frame, depositing a quantity of adhesive on a surface of  
24 the sheet, securing the folds of the sheet together by pressing an upper portion of the folded  
25 sheet against a lower portion having adhesive on its surface to form a protective cover, and  
26 adhering the cover to the picture frame by pressing the cover against adhesive on the molding  
27 surface.

1 Another object of the invention is to provide an apparatus for bending a  
2 cardboard preform cut to a pre-determined shape over the corner of the picture frame,  
3 securing the folded portions of the cardboard preform by compressing a liquid adhesive  
4 therebetween and allowing the liquid adhesive to solidify, thereby forming a corner protector,  
5 and securing the corner protector to a molding of the frame by compressing a liquid adhesive  
6 between the molding and corner protector and allowing the liquid adhesive to solidify, thereby  
7 adhesively bonding the corner protector to the frame.

8 Another object of the invention is to provide a picture frame corner protector  
9 attaching apparatus which includes means for clamping and holding a corner of a picture  
10 frame, positioning under the picture frame corner a preform sheet of flexible material, the  
11 preform sheet having the shape of left and right, lower and upper right triangular-shaped cover  
12 flaps joined at their inner vertical edges by a vertically elongated, rectangular-shaped inner  
13 spine flap to form a shape approximating that of a truncated isosceles triangle, the preform  
14 having a horizontally elongated, rectangularly-shaped outer spine flap depending downwardly  
15 from the left triangular corner flap and shaped similarly to the inner spine flap, and having  
16 depending downwardly therefrom a trapizoidally-shaped securement flap, means for spraying  
17 a first quantity of adhesive onto the upper surface of a first frame molding overlying the lower  
18 triangular-shaped cover flap, bending the outer spine flap vertically upwards into contact with  
19 the outer lateral side of the first frame molding, bending the securement flap down into a  
20 horizontal position in contact with the adhesive on the surface of the first frame molding,  
21 bending the inner spine flap and upper triangular cover flap vertically upwards into contact with  
22 the outer lateral surface of the second frame molding, spraying a second quantity of adhesive  
23 onto the upper surface of the securement flap overlying the first quantity of adhesive and  
24 bending the upper triangular cover flap into compressive contact with the second quantity of  
25 adhesive, thereby securing the upper triangular cover flap to the securement flap to form a  
26 completed cover protector, and pressing the first quantity of adhesive between the lower  
27 surface of the securement flap and the upper surface of the first frame molding to thereby  
28 secure the corner protector to the frame.

Various other objects and advantages of the present invention, and its most novel features, will become apparent to those skilled in the art by perusing the accompanying specification, drawings and claims.

It is to be understood that although the invention disclosed herein is fully capable of achieving the objects and providing the advantages described, the characteristics of the invention described herein are merely illustrative of the preferred embodiments. Accordingly, I do not intend that the scope of my exclusive rights and privileges in the invention be limited to details of the embodiments described. I do intend that equivalents, adaptations and modifications of the invention reasonably inferable from the description contained herein be included within the scope of the invention as defined by the appended claims.

#### SUMMARY OF THE INVENTION

Briefly stated the present invention comprehends a method and apparatus for automatically and adhesively bonding protective covers made of a sheet of flexible material, e.g., cardboard, stock to the corners of frames, particularly rectangularly-shaped frames of the type used to hold pictures, documents and the like, the covers being intended to protect the corners of the frame from damage during shipment.

A preferred embodiment of an automatic adhesive bonding method and apparatus according to the present invention preferably utilizes corner protectors made from thin, flat sheets of cardboard, each pre-cut, by die cutting, for example, into a generally triangular shape which includes panel sections which are bent out from the plane of the sheet to form cover flaps which are to be folded over and enclose a corner and adjacent portions of the side channel members of a conventional rectangularly-shaped picture frame. Four such corner protectors are used to cover the four corners of the frame.

In a preferred embodiment of the invention, the plan view shape of the upper, larger portion of the corner protector preform includes two mirror symmetric, left and right, right-triangularly-shaped, panel sections having collinear horizontal bases joined to opposite vertical sides of a vertically elongated rectangular, inner, or right-hand spine panel section. The left and right triangularly-shaped panel sections serve as lower and upper cover flaps,

1 while the inner spine panel section serves as a first, right-hand spine cover flap for a picture  
2 frame corner, as will be described below. Thus shaped, the upper portion of the preform has  
3 the appearance of an isosceles triangle whose vertex is horizontally truncated. The preform  
4 preferably includes a lower portion that has a horizontally elongated, rectangularly shaped  
5 outer, or left-hand spine flap panel section which depends downwardly from the base of one  
6 of the right-triangle flap panels, the left one, for example, and has the same width as that  
7 panel. A trapezoidally-shaped securement flap panel section depends downwardly from the  
8 bottom edge of the outer spine flap panel, the securement flap panel having a lower edge wall  
9 parallel to but shorter than that of the outer spine flap panel. In a preferred embodiment, the  
10 horizontal width of the vertically elongated inner spine flap panel and the vertical height of the  
11 horizontally elongated outer spine flap panel have a common value which is slightly greater  
12 than the thickness of a picture frame which is to be protected, e.g., about 15/16 inch for a  
13 frame thickness of 5/8 inch. Preferably, the vertical side walls of the vertical inner spine flap  
14 panel and the horizontally disposed upper and lower edges of the outer spine flap panel are  
15 scored to facilitate folding those respective flaps to contact adjacent perpendicular channel  
16 members or moldings of a picture frame.

17 According to the method of the present invention, a preform, score lines up, is  
18 positioned below a corner of a picture frame. The corner of the frame is oriented with respect  
19 to a preform with a pair of perpendicularly intersecting adjacent molding side walls defining  
20 the corner of the frame vertically aligned with the perpendicular sides of the left-hand, lower  
21 right-triangular cover flap having the downwardly depending outer spine and securement flaps.  
22 A first quantity of adhesive is then deposited on the upper surface of left-hand frame molding,  
23 near its intersection with the right-hand frame molding. Preferably, the first quantity of  
24 adhesive consists of one or more blobs of molten hot melt adhesive sprayed onto the upper  
25 surface of the molding from one or more nozzles of a pressurized hot melt glue gun positioned  
26 above the frame. The outer spine flap and securement flap are then folded vertically upwards  
27 as a planar unit along the upper or inner score line defining the junction between the base of  
28 the left, lower, right triangularly-shaped lower cover flap and the outer spine flap. Next, the

1 securement flap is folded downwardly and inwardly along the lower or outer score line towards  
2 a horizontal position, and the securement flap is pressed down onto the semi-liquid glue blobs  
3 on the upper surface of the frame member overlying the left, lower triangularly-shaped cover  
4 flap. A second quantity of adhesive is then deposited on the upper surface of the securement  
5 flap by the glue gun. Then, the second, right-hand, right-triangularly-shaped upper cover flap  
6 and inner spine flap are bent upwards as a unit along the innermost vertical fold line, i.e., the  
7 left-hand vertical edge of the inner spine flap, to a vertical position. The right-hand, upper  
8 triangular cover flap is then bent downwardly and laterally along the outermost, right-hand  
9 vertical fold line of the inner spine flap to a horizontal position overlying the securement flap  
10 and pressed down against the second quantity of adhesive on the upper surface of the  
11 securement flap, thus securing the overlying, upper right-hand triangular cover flap to the  
12 securement flap.

13           The apparatus according to the present invention includes a base plate or work  
14 table having a flat upper surface for supporting a corner of a picture frame, and a frame holder  
15 clamping jig for receiving and holding the corner of the picture frame on the surface of the  
16 table.

17           Mounted on the table is a corner protector installation mechanism which includes  
18 a pair of corner protector flap folder actuators positioned on opposite sides of the corner of a  
19 picture frame held in the clamping jig. Each corner folder actuator includes a flat,  
20 rectangularly-shaped flap-contacting arm mounted near a longitudinal end thereof on the upper  
21 end of a post which is actuable by a linear actuator from a lower inactive position in which the  
22 arm resides within a rectangularly-shaped recess in the upper surface of the base plate, with  
23 the upper surface of the arm flush with the upper surface of the base plate, to an upper, active  
24 position. Each post also includes a 90-degree rotary actuator means, which is effective in  
25 rotating a flap contacting arm, when raised, from an outer position contacting the outer  
26 vertically disposed side of a flap to an inner position effective in exerting an inwardly and  
27 downwardly directed folding force on the flap.

1 In operation, the first corner folder actuator arm is extended vertically, folding the  
2 outer spine flap and securement flap upwardly into a vertical position adjacent one side of a  
3 frame. An automatic hot melt adhesive gun applicator head having nozzles pressurized by air  
4 then deposits sprays a first quantity of hot melt adhesive onto the upper surface of the frame  
5 molding adjacent to the first folder actuator arm. The arm is then rotated inwards, bending the  
6 securement flap inwardly and downwardly into contact with the first quantity of semi-liquid  
7 adhesive on the upper surface of the first frame molding strip, thus bonding the securement  
8 flap to the frame.

9 Next, the actuator arm of the second corner folder actuator is elevated, folding  
10 the upper triangular corner protector flap upwardly to a position vertically adjacent the outer  
11 edge of the second frame molding strip. The arm of the first corner folder actuator is then  
12 rotated outwardly from its position overlying and holding down the securement flap. A second  
13 quantity of molten hot melt adhesive is then sprayed onto the upper surface of the securement  
14 flap. The arm of the second actuator is then rotated inwardly, bending the upper triangular  
15 cover flap down into contact with the securement flap. This action presses the upper triangular  
16 cover flap down against the second quantity of adhesive on the upper surface of the  
17 underlying securement flap, thereby securing adhering the flaps to each other. The applicator  
18 head is then moved forcibly downwards by a pneumatic actuator, causing a pair of fingers  
19 protruding downwardly from the head to press downwardly on the upper surface of the upper  
20 triangular cover flap, causing secure adhesive bonds to be formed between the securement  
21 flap and frame, and between the upper triangular cover flap and securement flap. Both  
22 actuator arms are then automatically rotated and retracted to their recessed positions, flush  
23 with the work table surface. At the same time, the frame holding clamp is also automatically  
24 released, allowing the frame with attached corner protector to be removed from the clamp.

25 The apparatus according to the present invention may optionally include means  
26 for automatically and substantially simultaneously initiating operation of a pair of corner  
27 protector installation mechanisms of the type described above, each time two adjacent corners  
28 of a picture frame are fully inserted into and correctly oriented with respect to clamping jigs of



1 the mechanisms. In a preferred embodiment, apparatus components for implementing this  
2 automatic operation include a pair of guide plates in each clamping jig that have inner vertically  
3 disposed wall surfaces that define therebetween a ninety degree intersection angle or vertex,  
4 which is cut off or truncated by a plane oriented at forty-five degrees to the guide bars, to  
5 thereby form an opening for insertably receiving the corner of picture frame, with the  
6 intersecting channel moldings of the frame aligned with the guide plates.

7 Each guide plate is provided, near the opening between the inner longitudinal  
8 ends of the guide plate, with a sensor which provides an electrical signal indicating that a  
9 frame corner molding has been fully inserted into the clamping jig. The electrical signals from  
10 each pair of sensors for each of the two clamping jigs are logically ANDed, producing a  
11 command signal to initiate automatic operation of the machine only when all three outer sides  
12 of the frame channel moldings defining two adjacent corners of the frame are fully inserted into  
13 and properly aligned with the guide plates of the two clamping jigs for proper operation of the  
14 corner protector folding and attaching operation. This command signal initiates a sequence  
15 of operations by which a pair of corner protectors are automatically attached in tandem to the  
16 two corners of a picture frame. Upon completion of this automatic operation, the holding  
17 clamps of both clamping jigs are automatically released, allowing the frame with a pair of  
18 attached corner protectors installed to be withdrawn from engagement with the apparatus. The  
19 frame may then be rotated one hundred and eighty degrees in a horizontal plane, and re-  
20 inserted into the apparatus to initiate attachment of a pair of corner protectors to the remaining  
21 two corners of the picture frame.

#### 22 BRIEF DESCRIPTION OF THE DRAWINGS

23 Figure 1 is a front perspective view of an apparatus for adhesively bonding corner  
24 protectors onto picture frames according to the present invention, showing a hot melt adhesive  
25 machine comprising part of the apparatus.

26 Figure 2 is a fragmentary upper rear perspective view of the apparatus of Figure  
27 1 on an enlarged scale, and showing guide rods and preforms used therewith removed to  
28 show details of the apparatus.

1 Figure 3 is a front perspective view of an adhesive applicator head comprising  
2 part of the apparatus of Figure 1.

3 Figure 4 is a front elevation view of the applicator head of Figure 3.

4 Figure 5 is a side elevation view of the applicator head of Figure 3.

5 Figure 6 is a lower plan view of the applicator head of Figure 3.

6 Figure 7 is an upper plan view of a corner protector preform or blank usable with  
7 the apparatus of Figure 1.

8 Figure 8 is a rear perspective view of the apparatus of Figure 2 showing a supply  
9 of corner protector preforms or blanks of the type shown in Figure 7 in a stack preparatory to  
10 feeding individual preforms into a clamping position on the apparatus.

11 Figure 9 is a rear perspective view similar to that of Figure 8, but showing an  
12 individual corner protector preform advanced to a clamping location, and showing a corner  
13 protector in a stack from which the individual corner protector was advanced.

14 Figure 10 is a view similar to that of Figure 9, but showing a corner of a picture  
15 frame inserted into a clamping jig comprising part of the apparatus, the picture frame corner  
16 being positioned above the individual corner protector preform of Figure 9, and showing a  
17 clamp bar of the clamping jig brought down into compressive contact with the upper surface  
18 of the picture frame.

19 Figure 11 is a view similar to that of Figure 10, but showing streams of adhesive  
20 issuing from the adhesive applicator head of Figures 3 through 6, the streams impinging on  
21 the upper surface of a channel member of the picture frame to thereby deposit thereon a first  
22 adhesive blob consisting of two glue dots.

23 Figure 12 is a view similar to that of Figures 10 and 11, but showing a first corner  
24 flap actuator comprising part of the apparatus in an upwardly actuated position.

25 Figure 13 is a view of the apparatus of Figure 1 similar to that of Figure 12, but  
26 showing a fold-effecting arm of the first corner flap actuator rotated to contact and fold down  
27 a securement flap of the corner protector preform into a position overlaying the picture frame.  
28

1 Figure 14 is a view similar to that of Figure 13, but showing streams of adhesive  
2 issuing from the adhesive applicator head of Figures 2 through 6, the streams impinging on  
3 the upper surface of the securement flap to thereby deposit thereon a second adhesive blob  
4 consisting of two glue dots.

5 Figure 15 is a view of the apparatus similar to that of Figure 13, but showing a  
6 second corner flap actuator of the apparatus in an upwardly actuated position.

7 Figure 16 is a view of the apparatus of Figure 1 similar to that of Figure 15, but  
8 showing a fold-effecting arm of the second corner flap actuator rotated to contact and fold  
9 down a triangularly-shaped upper cover flap of the corner protector preform into a position  
10 overlying the securement flap of the corner protector preform.

11 Figure 17 is a view of the apparatus of Figure 1 similar to that of Figure 16, but  
12 showing the fold-effecting arm of the first corner flap actuator rotated back into an inactive,  
13 home position, and showing an adhesive applicator head comprising part of the apparatus  
14 actuated downwardly to thereby press a flat lower portion of the head forward of nozzles  
15 protruding downwardly from the head into compressive contact with the upper surface of that  
16 portion of the second, triangularly-shaped upper cover flap overlying the securement flap of  
17 the corner protector preform, thereby pressing the glue dots between the flaps together to  
18 thereby adhere the flaps together and thereby pressing the lower surface of the securement  
19 flap against the glue dots on the picture frame channel molding, thereby adhering the  
20 securement flap to the picture frame.

21 Figure 18 is a fragmentary side elevation view of the apparatus of Figure 17,  
22 showing the applicator head on an enlarged scale, but in a partially lowered position.

23 Figure 19 is a view similar to that of Figure 18, but showing the applicator head  
24 in a fully lowered position, as shown in Figure 17.

#### 25 DESCRIPTION OF THE PREFERRED EMBODIMENTS

26 Figures 1-19 depict a method and apparatus according to the present invention  
27 for adhesively bonding corner protectors onto picture frames and the like. The structure and  
28 function of certain portions of the apparatus according to the present invention are described

1 in detail in the present inventor's U.S. Patent No. 6,018,934, the entire specification, claims,  
2 drawings, and abstract which are hereby incorporated by reference into the present  
3 application.

4 Referring now to Figures 1 and 2, an apparatus 20 for adhesively bonding corner  
5 protectors onto the corners of picture frames and the like may be seen to include a corner  
6 protector installation mechanism 30. Mechanism 30 is similar in structure and function to the  
7 apparatus disclosed in U.S. Patent No. 6,018,934. Notably, however, as will be described in  
8 detail below, mechanism 30 according to the present invention utilizes an adhesive dispensing  
9 gun rather than the staple gun disclosed in the '934 patent. Thus, corner protector installation  
10 mechanism 30, in contrast to the apparatus disclosed in the '934 patent, can be used to install  
11 corner protectors on frames, such as metal or plastic frames, where it would not be feasible  
12 to staple the protector to the frame.

13 As shown in Figures 1 and 2, corner protector installation mechanism 30 includes  
14 a generally rectangular box-shaped enclosure 31 surmounted by a generally flat, upper base  
15 plate or work table 32. As may be seen best by referring to Figure 1, apparatus 30 includes  
16 an elongated, generally straight frame holder/clamping jig 33 mounted on the upper surface  
17 34 of work table 32. Preferably, clamping jig 33 is disposed obliquely, e.g., at 45 degrees, with  
18 respect to the rectangular plan-view shape of work table 32. As shown in Figures 1, 8, 10 and  
19 18, clamping jig 33 is spaced above upper surface 34 of table 32, and includes a longitudinally  
20 elongated, horizontally disposed, generally rectangular-shaped upper straight beam member  
21 35, supported at opposite transverse ends thereof by a pair of laterally opposed, left and right  
22 guide plates 36L, 36R, respectively. Guide plates 36 have flat and parallel lower and upper  
23 surfaces, 236 and 237, these surfaces supporting clamp beam member 35 so that its lower  
24 surface 37 is parallel to and spaced above upper surface 34 of work table 32.

25 As shown in Figure 1, enclosure 31 of mechanism 30 has parallel, vertically  
26 disposed left and right side panels 72 and 73, which are perpendicular to front and rear  
27 vertically disposed panels 75, 74. Front panel 75 is preferably joined to left and right side  
28 panels 72, 73 by left and right vertically disposed transition panels 28, 29. The latter are

1 obliquely angled to front panel 75, e.g., at 45 degrees. This construction enables pairs of  
2 mechanisms 30 to be oriented with longitudinal axes of the mechanism, defined by a horizontal  
3 line centered in work table 32 and perpendicular to front panel 75, perpendicular to one  
4 another, with transition panels 29, 28 of mechanisms 20 spaced closely next to one another.  
5 Thus arranged, pairs of mechanisms 30 may optionally be employed in tandem, in a manner  
6 similar to that described in co-pending application Serial No. 09/687,358, filed 10/13/00, the  
7 entire disclosure of which is hereby incorporated by reference into this present application.

8 As shown in Figures 1 and 18, left and right guide plates 36L and 36R have inner  
9 longitudinally disposed vertical wall surfaces 238L and 238R, respectively. If extended  
10 inwardly or rearwardly towards the center of work table 32, inner vertical surfaces 238L and  
11 238R of guide plates 36L and 36R would intersect to form a right angle corner. However, as  
12 shown in Figures 1, 2, and 18, inner ends of guide plates 36L and 36R are truncated by an  
13 obliquely disposed cutting plane which forms obliquely disposed inner vertical transverse face  
14 walls 239L and 239R, respectively, that are coplanar with the cutting plane, and angled at 45  
15 degrees to inner vertical side walls 238L and 238R. Thus arranged, inner vertical side walls  
16 238L and 238R form guide surfaces along which may be slid the outer side walls of side  
17 channel members or moldings of a rectangular picture frame that intersect each other at a  
18 ninety-degree corner. A laterally disposed space 240 between opposed inner corners 241L  
19 and 241R of guide plates 36L and 36R allows the corner of a picture frame to protrude  
20 inwardly beyond inner face walls 239L and 239R of the guide plates.

21 As may be seen best by referring to Figures 1, 8, 10, and 18, clamping jig 33  
22 includes a horizontally disposed, elongated straight clamp bar 38 located below and in vertical  
23 alignment with clamp beam member 35. Clamp bar 38 is vertically movably held with respect  
24 to clamp beam member 35. Thus, as shown in Figures 1, 8, and 18, clamping jig 33 includes  
25 a linear actuator comprising a double acting pneumatic cylinder 40, for raising and lowering  
26 clamp bar 38. Clamp bar cylinder 40 is mounted on the upper surface 41 of clamping jig  
27 support beam 35, and has a piston rod 42 which protrudes vertically downwards through a  
28 bore 43 provided through the thickness dimension of the support beam. The lower end of

1 piston rod 42 has a square transverse sectional shape which protrudes through a similarly  
2 shaped bore through clamp bar 38, and is secured to the clamp bar by a screw 39. Since  
3 pneumatic cylinder 40 is of the type in which piston rod 42 is non-rotatable, clamp bar 38 is  
4 maintained in a fixed horizontal orientation when moved vertically with respect to work table  
5 32.

6 As shown in Figures 2 and 18, clamp bar cylinder 40 has an upper pressurized  
7 "down" air inlet port 44 connected to a first "down" air inlet hose 45, and a second, lower, "up"  
8 air inlet port 46 connected to a second, "up" air inlet hose 47. Hoses 45 and 47 connect to  
9 tubular fittings 48 and 49 which protrude downwards through upper surface 34 of work table  
10 32, to control valves and a source of pressurized air, as will be discussed in detail below.  
11 When pressurized air is supplied to "up" inlet port 46 of clamp air cylinder 40, pressurized air  
12 on the lower side of a piston within the cylinder forces the piston, attached piston rod 42, and  
13 attached clamp bar 38 upwards to an upper, unlocked position, as shown in Figure 1.  
14 Conversely, when pressurized air is supplied to "down" inlet port 44 of clamp air cylinder 40,  
15 pressurized air on the upper side of the piston within the cylinder forces the piston and clamp  
16 bar 38 downwards to a lower position in clamping contact with a picture frame A, as shown in  
17 Figure 10.

18 A preferred embodiment of mechanism 30 according to the present invention  
19 includes a feeder mechanism 70 for automatically feeding a single corner protector preform  
20 50 at a time to a pre-determined position beneath clamping bar 38 of clamping jig 33, prior to  
21 inserting a frame to be protected into the clamping jig. The structure and function of feeder  
22 mechanism 70 may be best understood by first reviewing the construction of corner protector  
23 preforms 50 used with apparatus 30. Figure 7, shows a corner protector preform 50 of the  
24 type the apparatus 30 is intended to be used with.

25 As shown in Figure 7, preform 50 is made of a thin sheet of readily bendable  
26 material, such as corrugated cardboard. Preform 50 has two laterally mirror symmetric, left  
27 and right right triangularly-shaped panel sections bendable out the plane of the sheet to form  
28 lower and upper triangular cover flaps 51 and 52, respectively. In the orientation of preform

50 shown in Figure 7, flap 51 is on the left-hand side of the figure, and will be referred to as the left-hand flap as a matter of convenience throughout the ensuing discussion. Left and right, lower and upper triangular cover flaps 51 and 52 have collinear horizontal bases 53 and 54 joined at their respective ninety degree corner angles to opposite vertical sides 55 and 56 of a vertically elongated, rectangular panel section comprising an inner spine flap 57, which has a base 58 collinear with the bases of the triangles. Thus shaped, preform 50 has an appearance approximating that of an isosceles triangle having a horizontal base 53-58-54 and an upper vertex truncated by a horizontal edge 59 parallel to the base.

Referring still to Figure 7, preform 50 may be seen to include a horizontally elongated, rectangularly shaped panel section comprising an outer spine flap 60 which depends downwardly from base 53 of left-hand triangular flap 51, and has the same width as that flap. A trapezoidally-shaped securement flap 61 depends downwardly from the bottom edge wall 62 of outer rectangular spine flap 60, the securement flap having an upper edge wall coextensive with bottom edge wall 62 of the outer spine flap, and a lower edge wall 63 parallel to but shorter than edge wall 62.

In a preferred embodiment of corner protector preform 50, the width of inner, vertical spine flap 57 and the height of outer, horizontal spine flap 60 are each equal to a common value which is slightly greater than the thickness of a typical picture frame, e.g., about 15/16 inch, for a frame thickness of 7/8 inch. As shown in Figure 7, preform 50 is preferably scored along edge walls 55 and 56 of inner, vertical spine flap 57, and along edge walls 53 and 62 of outer, horizontal spine flap 60. These score lines are located along boundaries between adjacent flaps, and facilitate folding the flaps out from the plane of a preform and around a picture frame corner, as will be explained below.

Referring again to Figures 2 and 8, corner protector feeder mechanism 70 may be seen to include a longitudinally elongated, rectangularly shaped guide plate 71 having a generally flat upper surface mounted above and parallel to upper surface 34 of work table 32. Guide plate 71 is oriented with its long axis parallel to left and right side walls 72 and 73 of enclosure 31, and protrudes rearwardly beyond rear side wall 74 of the enclosure. As shown

1 in Figures 1, 2, and 8, guide plate 71 of feeder mechanism 70 has through its thickness  
2 dimension a perforation 76 having substantially the same outline shape as corner protector  
3 preform 50. Guide plate 71 is spaced above upper surface 34 of table 32 by longitudinally  
4 disposed support ribs 82, at a distance slightly greater than the thickness of corner protector  
5 preform 50, e.g., 5/16 inch for preforms having a thickness of about 1/4 inch. Thus, a corner  
6 protector preform 50 placed conformally over perforation 76 will drop through the aperture onto  
7 work table surface 32, allowing the preform to be slid into operating position under clamping  
8 jig 33, as will be described in detail below.

9 As may be seen best by referring to Figure 9, feeder mechanism 70 includes a  
10 pusher plate 79 longitudinally slidably mounted in longitudinally disposed guideways consisting  
11 of grooves 80 provided in inner facing walls 81 of guide plate support ribs 82. Pusher plate  
12 79 has a generally uniform thickness, and has a front edge wall 83 in which is formed a groove  
13 shaped complementarily to the lower edge wall of preform 50. Preferably, pusher plate 79 is  
14 made of DELRIN, NYLON, or a similar structural polymer that has good lubricity.

15 As shown in Figure 9, pusher plate 79 has protruding perpendicularly from a rear  
16 edge 85 thereof an elongated straight push rod member 84 which protrudes rearwardly of rear  
17 vertical wall panel 74 of enclosure 31. Push rod 84 is reciprocally and cyclically actuated  
18 longitudinally, i.e., perpendicularly to rear edge 85 of pusher plate 79, in a forward direction to  
19 feed a preform 50 forward under clamping jig 33, and rearwardly to retract front edge 83 of the  
20 pusher plate into alignment with the rear edge wall of aperture 76 through guide plate 71, to  
21 thereby enable a next preform 50 in a stack to drop through the aperture preparatory to its  
22 being fed forward for installation on another picture frame corner. In a preferred embodiment,  
23 push rod 84 is coupled to the piston of a double acting pneumatic cylinder (not shown) used  
24 to cyclically advance and retract pusher plate 79.

25 In a preferred embodiment of apparatus 20, as shown in Figure 1, corner  
26 protector installation mechanism 30 includes a plurality of vertically disposed guide rods 77  
27 which protrude perpendicularly upwards from upper surface 34 of work table 32. Guide rods  
28 77 define between tangents to the outer wall surfaces of inner facing sides of the rods a



1 uniform transverse cross-section, vertically disposed bore 78 which is vertically aligned with  
2 guide plate perforation 76 and which is adapted to receive a vertical stack of preforms 50.

3 Referring now to Figures 1, 2 and 8, it may be seen that corner protector  
4 installation mechanism 30 includes an adhesive dispensing apparatus 101 for dispersing  
5 quantities of adhesive used for bonding corner protectors 50 to picture frames. In a preferred  
6 embodiment, adhesive dispensing apparatus 101 includes a hot melt adhesive machine, such  
7 as the Autotech Model AT15 Hotmelt Unit, manufactured by the Slautterback Corporation,  
8 located at 5 Lower Ragsdale Drive, Monterey, CA 93940-5779. As shown in Figure 2, this  
9 embodiment of an adhesive dispensing apparatus includes a machine 102 for melting solid  
10 polymer sticks and pumping the molten polymer, and a thermally blanketed, high pressure  
11 hose 103 for conveying hot, molten polymer adhesive to an applicator head 104. As shown  
12 in Figures 3-6, applicator head 104 has a horizontally elongated body 105 including a generally  
13 rectangular block-shaped front portion 106 having a flat, horizontally disposed lower surface  
14 107 from which protrude one or preferably two adhesive dispensing nozzles 108. Hot melt  
15 adhesive dispensing apparatus 101 includes a pressurized air hose 109 and electrical control  
16 cable 110 which are interconnected between hot melt pumping machine 102 and applicator  
17 head 104. Machine 102 includes a melting tank (not shown) located below a hinged lid 111  
18 for receiving and melting sticks of hot melt polymer adhesive, such as H. B. Fuller type HL  
19 9254 hot melt adhesive received into the tank. This type adhesive has a working temperature  
20 range of about 270 °F to 325 °F. Machine 102 includes an internal heater, and internal control  
21 mechanisms which, in response to electrical command signals supplied from an external  
22 source, pump molten hot melt adhesive from the melting tank through delivery hose 103 to  
23 applicator head 104. Internal control mechanisms within machine 102 also provide electric  
24 signals through control cable 110 to applicator head which control pressurized air supplied to  
25 the had through hose 109. which operate valves within the head, causing jets of pressurized  
26 liquid hot melt adhesive to be sprayed from nozzles 108 upon receipt of an external command  
27 signal.  
28

1 As may be seen best by referring to Figures 2, 8, and 18, corner protector  
2 installation apparatus 20 includes an adjustable support structure 118 for holding and  
3 supporting at an adjustable longitudinal distance, or throat depth, applicator head 104 of the  
4 apparatus relative to a picture frame held in clamp jig 33.

5 Support structure 118 is mounted on the upper end of a compressor/elevator  
6 actuator mechanism 119 which lowers applicator head 104 to force a pair of fingers 141 having  
7 flat, co-planar horizontally disposed anvil surfaces 142 which protrude downwards from a front  
8 flat anvil portion 120 of head 104 into compressive contact with a corner protector 50 on a  
9 picture frame to press flaps of the corner protector preform into bonding contact with semi-  
10 liquid hot melt adhesive, upon completion of the adhesive application operation, as will be  
11 explained in detail below.

12 As may be seen best by referring to Figures 2, 8, and 18, compressor/elevator  
13 actuator 119 of hot melt adhesive dispensing apparatus 101 includes a row of three vertically  
14 disposed, laterally spaced apart and aligned support rods 121 fastened at the upper ends thereof to the  
15 lower portion of spray gun applicator head support structure 119A. Support rods 121 are vertically  
16 slidably supported in sleeve bearings 122 located below an elongated rectangular base plate 123. Base  
17 plate 123 is fastened to a structural member 124 within enclosure 31, and is located below a similarly-  
18 shaped aperture 125 through work table 32.

19 Referring now to Figures 2 and 8-10, corner protector installation mechanism 30 may be  
20 seen to include a pair of corner flap folder actuators 130L and 130R located on the left and right sides,  
21 respectively, of a longitudinal center line of work table 32 of the apparatus. As shown in Figure 2, flap  
22 folder actuators 130L and 130R are located longitudinally inwards of clamping jig 33, in a location that  
23 places the actuators adjacent to the sides of a frame inserted inwardly under clamp bar 38 of clamping  
24 jig 33. Flap folder actuators 130L and 130R are identical in structure and function. Therefore, in the  
25 ensuing description, the flap folder actuators will be referred to generally without a subscript.

26 As shown in Figures 2 and 8, each flap folder actuator 130, such as left-hand folder  
27 actuator 130L, may be seen to include a flat, rectangularly-shaped flap folder arm 131 which fits into a  
28 complementarily shaped recess 129 provided in upper surface 34 of work table 32, flush with the upper

1 surface. Arm 131 is oriented with a long, inner longitudinal edge 132 thereof parallel and adjacent to  
2 a side of a picture frame protruding diagonally inwardly from beneath clamp bar 38 of clamping jig 33.

3 As may be seen best by referring to Figure 12, each flap holder arm 131 is  
4 mounted on the upper transversely disposed horizontal end wall 133 of a vertically disposed,  
5 cylindrically-shaped support post 134. Also, corner protector installation mechanism 30  
6 includes a linear actuator for elevating support post 134 along its longitudinal axis, to thereby  
7 elevate flap folder arm 131 attached to the upper end of the support post upwardly from its rest  
8 position recessed in upper surface 34 of work table 31, and a rotary actuator for reciprocally  
9 rotating elevator support post 134 about its longitudinal axis, to thereby rotate the flap folder  
10 arm ninety degrees away from and back to its rest position, where the linear actuator retracts  
11 the flap folder arm into recess 129.

12 Corner protector installation mechanism 30 according to the present invention  
13 also includes preferably sensor means which provides a signal indicating that a corner of a  
14 picture frame has been fully inserted into clamping jig 33, with the frame moldings adjacent the  
15 corner parallel to and proximate inner vertical wall surfaces 238R, 238L of guide plates 36R,  
16 36L.

17 Various types of proximity or optical sensors suitable for the foregoing purpose  
18 are well known to those skilled in the art. In an example embodiment of apparatus 20 tested  
19 by the present inventor, each sensor 170 consisted of a UZJ-111, fixed-focus type micro-photo  
20 sensor, manufactured by Matsushita Electric Works, Ltd., Automation Controls Group, 1048  
21 Kadoma, Osaka 571, Japan. That sensor contains an infrared light emitting diode and  
22 phototransistor arranged within a circuit module with their optical axes generally parallel, and  
23 their respective exit and entrance pupils adjacent each other behind an infrared window  
24 comprising the outer face of the module. When a surface such as the outer surface of a  
25 picture frame molding is positioned within about  $5\text{ mm} \pm 2.5\text{ mm}$  of the outer face of the  
26 sensor, an output transistor within the sensor is turned on, providing a logic TRUE current  
27 through a load resistor connected in series with a collector supply voltage, and the emitter and  
28 collector output terminals of the sensor.

As shown in Figure 1, a pair of sensors 170R, 170L of the type described above with their outer faces installed in guide plates 36R, 36L, flush with inner surfaces 238R, 238L of guide plates 36R, 36L, respectively, near the inner transverse vertical end walls 171R, 171L thereof, and near upper surface 34 of work table 32. Each sensor 170 produces a logic TRUE signal when a frame molding is parallel to and a predetermined distance from inner surface 238R, 238L adjacent the outer face of the sensor. Moreover, apparatus 20 includes an electronic AND circuit 172 for logically ANDING signals from the output terminals of two sensors 170R, 170L of corner protector installation mechanism 30. The output signal from the AND circuit is false when either of the 2 sensors 170R, 170L outputs a false signal, indicating that a picture frame molding near that sensor is not substantially close to and parallel to the sensor. However, when the corner of a frame has been fully inserted into and properly aligned with clamping jig 33 of corner protector installation mechanism 30 of apparatus 20. The logical AND circuit produces a TRUE output signal which initiates a sequence of automatic operations of the corner protector installation mechanism, which are described below. Electronic circuitry for performing the foregoing functions is well known to those skilled in the art, and therefore need not be described in further detail here. For example, such circuitry can be implemented in a Programmable Logic Controller, PLC 133, or a general purpose microprocessor or micro controller.

#### OPERATION OF THE INVENTION

In response to a TRUE output signal from AND circuit 172 when both sensors 170L, 170R produce TRUE output signals, Programmable Logic Controller (PLC) 133 issues in sequence drive signals to the various actuators of corner protector installer mechanism 30 of apparatus 20 according to the present invention, as follows:

1. Vertical stacks of corner protector preforms 50 are loaded into bores 78 between guide rods 77 of feeder mechanisms 70 of installer mechanism 30. (Figures 1 and 8)
2. Power is turned on and PLC 133 resets and checks mechanism 30 of apparatus 20, readying the PLC for outputting sequential drive signal commands to the various actuators of the apparatus. A program for the operational sequence of apparatus 20 is stored in

1 electronic memory means in PLC 133. This program can be executed via an internal or  
2 external computer. (Figure 2)

3 3. Actuator cylinder 92 of feeder mechanism 70 in installer mechanism 30 is  
4 actuated to reciprocate piston rod 94, thereby moving an individual corrugated corner  
5 protector blank preform 50 forward into position below clamp bar 38 of the installer  
6 mechanism. (Figure 9)

7 4. A first corner C1 of a picture frame A having left and right channel moldings D  
8 and B is inserted into position beneath clamp bars 38 and over blank 50 of installer mechanism  
9 30. (Figure 10)

10 5. Frame A is positioned relative to apparatus 20 so that corner C1 of the frame is  
11 fully inserted into clamping jig 33 of mechanism 30. (Figure 10)

12 6. Sensors 170L, 170R of installer mechanism 30 output TRUE signals, causing  
13 AND circuit 172 to output a TRUE signal, in turn causing PLC 123 to simultaneously issue  
14 drive signals to the installer mechanism, as follows: (Figure 10)

15 7. Hold down clamp bar 38 of clamping jig 33 of mechanism 30 is forced downward  
16 onto the adjacent molding channels D and B of frame A which intersect at corner C1. (Figure  
17 10)

18 8. Hot melt adhesive machine 102 is then actuated, causing applicator head 104  
19 to spray blobs E of semi-liquid hot melt adhesive onto the upper surface of left-hand frame  
20 molding D. (Figure 11)

21 9. Blank preform 50 under corner C1 of frame A is automatically manipulated as  
22 follows: First, rectangular outer spine flap 60 and securement flap 61 of preform 50 are bent  
23 upwardly in unison into a vertically disposed orientation by elevating right-hand flap folder arm  
24 131R of mechanism 30 from its recess 129R, with the flap folder arm in its clockwise position.  
25 (Figure 12)

26 10. Securement flap 61 of preform 50 is bent inwardly and downwardly over left  
27 frame channel D by rotating right-hand flap folder arm 131R counterclockwise. (Figure 13)

1 11. Hot melt adhesive applicator head 104 is again actuated to spray blobs F of  
2 semi-liquid adhesive onto the upper surface of securement flap 61. (Figure 14)

3 12. Right-hand, upper triangular cover flap 52 and inner spine flap 57 of preform 50  
4 are bent as a unit into a vertically disposed orientation by extending right-hand flap folder arm  
5 162R upwardly from recess 129R. (Figure 15)

6 13. Upper cover flap 52 of preform 50 is bent inwardly and downwardly over right-  
7 hand frame channel B by rotating flap folder arm 152L ninety degrees clockwise. (Figure 16)

8 14. Right flap folder arm 131R is rotated ninety degrees clockwise to its angular rest  
9 position, and retracted downwardly into recess 129R to its vertical rest position. (Figure 17)

10 15. Hot melt adhesive applicator head gun 104 of mechanism 30 is lowered toward  
11 frame A, pressing fingers 141 protruding downwardly from front flat anvil portion 120 of the  
12 head, located forward of nozzles 108, down against upper flap 52, thereby pressing the flap  
13 down into blobs of adhesive between it and securement flap 61. (Figures 17, 18, 19)

14 16. Left flap folder arm 131L of mechanism 30 is rotated ninety degrees  
15 counterclockwise to its angular rest position. (Figure 2)

16 17. Left flap folder arm 131L of mechanism 30 is retracted downwardly into recess  
17 129L to its vertical rest position. (Figure 2)

18 18. Hold down clamp bar 38 of clamping jig 33 of mechanism 30 is retracted  
19 vertically upwards to its rest position, unclamping corner C1 of frame A. (Figure 9)

20 19. Frame A is retracted from apparatus 20, disengaging corner C1 from clamping  
21 jig 33.

22 20. Frame A is rotated ninety degrees in a horizontal plane, and steps 4-18 repeated  
23 to attach a corner protector 50 to a second corner C2 of frame A.

24 21. Step 20 is repeated for the remaining two corners C3, C4 of frame A.